CLAIMS

1. A method of working a metal, wherein a low deformation resistance region, which deformation resistance is locally reduced, is formed in a metal body, and the low deformation resistance region is subjected to shear deformation thereby to fine the microstructure of the metal body.

2. The method of working a metal according to claim 1, wherein the whole of said low deformation resistance region is subjected to said shear deformation.

3. The method of working a metal according to claim 1, wherein a portion of said low deformation resistance region is subjected to said shear deformation.

4. A method of working a metal comprising the steps of locally reducing the deformation resistance of a metal body extending in one direction; forming the low deformation resistance region crossing the metal body; and processing the low deformation resistance region and making it shear deformation, thereby making the microstructure of said metal body fine.

5. The method of working a metal according to claim 4, wherein said shear deformation proceeds in the central area of said low deformation resistance region.

6. The method of working a metal according to claim 4, wherein said shear deformation proceeds in the both ends of said low deformation resistance region.

7. The method of working a metal according to claim 4, wherein said shear deformation proceeds at one end of said low deformation resistance region.

8. The method of working a metal according to claims 4 to 7, wherein said

low deformation resistance regions are made to move along the extending direction of the said metal body.

9. A method of working a metal comprising the steps of locally reducing the deformation resistance of the metal body extending in one direction; forming the low deformation resistance region crossing the metal body; changing the position of one non-low deformation resistance region relative to the other non-low deformation resistance region in said metal body between which the low deformation resistance region is sandwiched; processing the low deformation resistance region and making it shear deformation, thereby making the microstructure of said metal body fine.

10. The method of working a metal according to claim 9, wherein said position change is caused by a vibration applied to said metal body in the direction approximately orthogonal to the extending direction of said metal body.

11. The method of working a metal according to claim 9, wherein said position change is caused by a compound motion comprising a first vibration applied to said metal body along a first direction approximately orthogonal to the extending direction of said metal body, and a second vibration applied to said metal body along a second direction approximately orthogonal to said first direction and the said extending direction of the metal body.

12. The method of working a metal according to claim 9, wherein said position change is caused by a twisting motion applied to said metal body about a virtual axis of rotation approximately parallel to the said extending direction of the metal body.

13. The method of working a metal according to claim 12, wherein heating

said metal body by means of heating mechanism to form said low deformation resistance regions, said heating mechanism forms a heating distribution without taking said virtual axis of rotation region as center.

14. The method of working a metal according to claim 13, making one said non-low deformation resistance region displace relative to another said non-low deformation resistance region along the direction approximately orthogonal to the extending direction of said metal body.

15. The method of working a metal according to any one of claims 9 to 14, wherein a compression stress is acted on said low deformation resistance regions along the extending direction of the said metal body.

16. The method of working a metal according to any one of claims 9 to 14, wherein said low deformation resistance regions are formed by heating said metal body by the heating mechanism provided between a first cooling mechanism and a second cooling mechanism.

17. The method of working metal according to any one of claims 9 to 11, wherein said metal body is a plate body.

18. The method of working a metal according to any one of claims 9 to 11, wherein said metal body is a plate body laminated with different metal layers.

19. The method of working a metal according to any one of claims 9 to 11, wherein said metal body is a plate body made from a mixing material including a first metal and a second metal.

20. The method of working a metal according to any one claims 9 to 12,

wherein said metal body is a hollow cylinder.

21. The method of working a metal according to any one of claims 9 to 12, wherein said metal body is a hollow cylinder laminated with different metal layers.

22. The method of working a metal according to any one of claims 9 to 12, wherein said metal body is a hollow cylinder made from a mixing material including a first metal and a second metal.

23. The method of working a metal according to any one of claims 9 to 12, wherein said metal body is a hollow cylinder and become a plate body by cutting the circumference of the hollow cylinder after said non-low deformation resistance region displacing.

24. The method of working a metal according to any one of claims 9 to 12, wherein said metal body is a hollow cylinder laminated with different metal layers and become a plate body by cutting the circumference of the hollow cylinder after said non-low deformation resistance region displacing.

25. The method of working a metal according to any one of claims 9 to 12, wherein said metal body is a hollow cylinder made from a mixing material including a first metal and a second material, and become a plate body by cutting the circumference of the hollow cylinder after said non-low deformation resistance region displacing.

26. The method of working a metal according to any one of claims 9 to 14, wherein said metal body is a round bar.

27. The method of working a metal according to any one of claims 9 to 14,

wherein said metal body is a bar laminated with different metal layers.

28. The method of working a metal according to any one of claims 9 to 14, wherein said metal body is a bar made from a mixing material including a first metal and a second metal.

29. The method of working a metal according to any one of claims 9 to 14, wherein said metal body is a bar made by at least bundling a first metal wire and a second metal wire together.

30. A method of working metal comprising the following steps: locally reducing the deformation resistance of the metal body extending in one direction; forming a first low deformation resistance region and a second low deformation resistance region crossing the metal body with a preset interval; and making said first low deformation resistance region and said second low deformation resistance region shear deformation, thereby making the microstructure of the metal body fine.

31. The method of working a metal according to claim 30, wherein the non-low deformation resistance region sandwiched between said first low deformation resistance region and said second low deformation resistance region is caused to vibrate along the direction approximately orthogonal to the extending direction of said metal body.

32. The method of working a metal according to claim 30, wherein the non-low deformation resistance region sandwiched between said first low deformation resistance region and said second low deformation resistance region is caused to vibrate along a first direction approximately orthogonal to the extending direction of said metal body, and vibrate simultaneously along a second direction

approximately orthogonal to the extending direction of the metal body and the first direction, respectively.

33. The method of working a metal according to claim 30, wherein the non-low deformation resistance region sandwiched between said first low deformation resistance region reach said second low deformation resistance region is caused to rotate about a virtual axis of rotation approximately parallel to the extending direction of said metal body.

34. The method of working a metal according to any one of claims 30 to 33, wherein said the first low deformation resistance region and said the second low deformation resistance region are formed by heating up to different temperatures, respectively.

35. A metal body, wherein a low deformation resistance region is formed by locally reducing the deformation resistance temporarily, and microstructure with refinement grain is obtained by making the low deformation resistance region shear deformation.

36. The metal body according to claim 35, wherein the said shear deformation occurs in the whole of said low deformation resistance region.

37. The metal body according to claim 35, wherein said shear deformation occurs in the portion of said low deformation resistance region.

38. A metal body, extending in one direction, wherein a low deformation resistance region crossing the metal body is formed by locally reducing the deformation resistance temporarily, a shear deformation occurs in the low deformation resistance region thereby to make the microstructure of the metal body

fine.

39. The metal body according to claim 38, wherein said shear deformation occurs in the center of said low deformation resistance region.

40. The metal body according to claim 38, wherein said shear deformation occurs at both ends of said low deformation resistance region.

41. The metal body according to claim 38, wherein said shear deformation occurs at one end of said low deformation resistance region.

42. The metal body according to claim 38 to 41, wherein said low deformation resistance region is made to displace along the extending direction of the said metal body.

43. A metal body, extending in one direction, wherein a low deformation resistance region crossing the metal body is formed by locally reducing the deformation resistance temporarily, which is sandwiched by non-low deformation resistance regions, one of the non-low deformation resistance region is caused to displace relative to the other non-low deformation resistance region, thus a shear deformation occurs in the low deformation resistance region, thereby the microstructure of metal body is rendered fine.

44. The metal body according to claim 43, wherein said displacement is caused by a vibration applied to said metal body in the direction approximately orthogonal to the extending direction of said metal body.

45. The metal body according to claim 43, wherein said displacement is caused by a compound motion comprising a first vibration along a first direction

approximately orthogonal to the extending direction of said metal body, and a second vibration along a second direction approximately orthogonal to said first direction and the said extending direction of the metal body.

46. The metal body according to claim 43, wherein said displacement is caused by a twisting motion about the virtual axis of rotation approximately parallel to the extending direction of said metal body.

47. The metal body according to claim 46, wherein said low deformation resistance region is formed by heating said metal body by means of heating mechanism, and said heating mechanism provides a heating distribution without taking said virtual axis of rotation region as center.

48. The method of working metal according to claim 46, wherein one said non-low deformation resistance region is caused to displace relative to another said non-low deformation resistance region along the direction approximately orthogonal to the extending direction of said metal body.

49. The metal body according to claims 43 to 48, wherein a compression stress is caused to act on non-low deformation resistance region along the extending direction of the said metal body.

50. The metal body according to any one of claims 43 to 48, wherein said non-low deformation resistance region is formed through heating said metal body by the heating mechanism provided between a first cooling mechanism and a second cooling mechanism.

51. The metal body according to any one of claims 43 to 45, wherein said metal body is a plate shape.

52. The metal body according to any one of claims 43 to 45, wherein said metal body is a plate body laminated with different metal layers.

53. The metal body according to any one of claims 43 to 45, wherein said metal body is a plate body made from a mixing material including a first metal and a second metal.

54. The metal body according to any one of claims 43 to 46, wherein said metal body is a hollow cylinder.

55. The metal body according to any one of claims 43 to 46, wherein said metal body is a hollow cylinder laminated with different metal layers.

56. The metal body according to any one of claims 43 to 46, wherein said metal body is a hollow cylinder made from a mixing material including a first metal and a second metal.

57. The metal body according to any one of claims 43 to 46, wherein said metal body is a hollow cylinder and become a plate body by cutting the circumference of the hollow cylinder after said non-low deformation resistance region displacing.

58. The metal body according to any one of claims 43 to 46, wherein said metal body is a hollow cylinder laminated with different metal layers and become a plate body by cutting the circumference of the hollow cylinder after said non-low deformation resistance region displacing.

59. The metal body according to any one claims 43 to 46, wherein said metal body is a hollow cylinder made from a mixing material including a first metal

and a second material and become a plate body by cutting the circumference of the hollow cylinder after said non-low deformation resistance region displacing.

60. The metal body according to any one of claims 43 to 48, wherein said metal body is a bar.

61. The metal body according to any one of claims 43 to 48, wherein said metal body is a bar laminated with different metal layers.

62. The metal body according to any one of claims 43 to 48, wherein said metal body is a bar made from a mixing material including a first metal and a second metal.

63. The metal body according to any one of claims 43 to 48, wherein said metal body is a bar made by at least bundling a first metal wire and the second metal wire together.

64. A metal body, extending in one direction, wherein a first low deformation resistance region and a second low deformation resistance region crossing the metal body with a preset interval are formed by locally reducing the deformation resistance temporarily forms, and the microstructure of the metal body with grain refinement is obtained by making said first low deformation resistance region and said a second low deformation resistance region suffer to shear deformation.

65. The metal body according to claim 64, wherein a non-low deformation resistance region sandwiched between said first low deformation resistance region and said second low deformation resistance region is caused to vibrate along the direction approximately orthogonal to the extending direction of said metal body.

66. The metal body according to claim 64, wherein a non-low deformation resistance region sandwiched between said first low deformation resistance region and said second low deformation resistance region is caused to vibrate along a first direction approximately orthogonal to the extending direction of said metal body, at the same time vibrate along a second direction approximately orthogonal to the extending direction of the metal body and the first direction.

67. The metal body according to claim 64, wherein a non-low deformation resistance region sandwiched between said first low deformation resistance region reach said second low deformation resistance region is caused to rotate about a virtual axis of rotation approximately parallel to the extending direction of said metal body.

68. The metal body according to any one of claims 64 to 67, wherein said the first low deformation resistance region and said the second low deformation resistance region are formed by heating up to different temperatures, respectively.

69. The metal body according to any one of claims 35 to 68, wherein said metal body is vehicle part.

70. The metal body according to any one of claims 35 to 68, wherein said metal body is any one of the following: Sputter target material, magnetic body, shape memory alloy, metal hydride, vibration damping alloy, electrothermal material, biological material, ship parts, aircraft components, parts of the load-carrying equipments except vehicles, building construction members.

71. A metal-containing ceramic body, extending in one direction, wherein a low deformation resistance region crossing the metal-containing body is formed by

locally reducing the deformation resistance temporarily, which is sandwiched by non-low deformation resistance regions, one of the non-low deformation resistance region is caused to displace relative to the other non-low deformation resistance region, thus a shear deformation occurs in the low deformation resistance region, thereby the microstructure of metal body is rendered fine.

72. The metal-containing ceramic body according to claim 71, wherein said displacement is caused by a twisting motion applied to the metal-containing body about a virtual axis of rotation approximately parallel to the said extending direction of the metal-containing body.